

Figure 1

REPLACEMENT SHEET

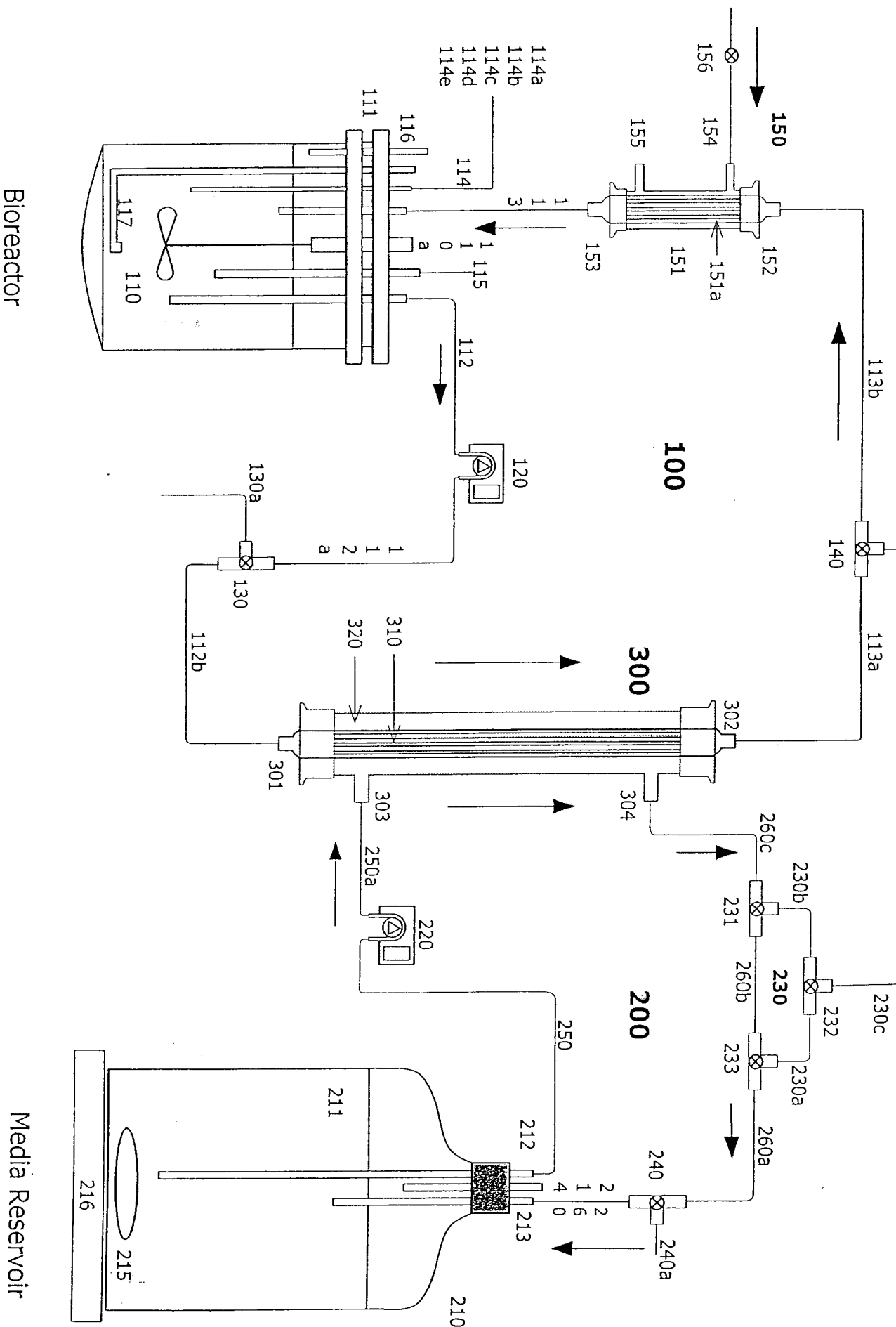


FIGURE 5 Growth of Insect Cells in a High-Density Dialysis Bioreactor with In-Line Oxygen Sparging.

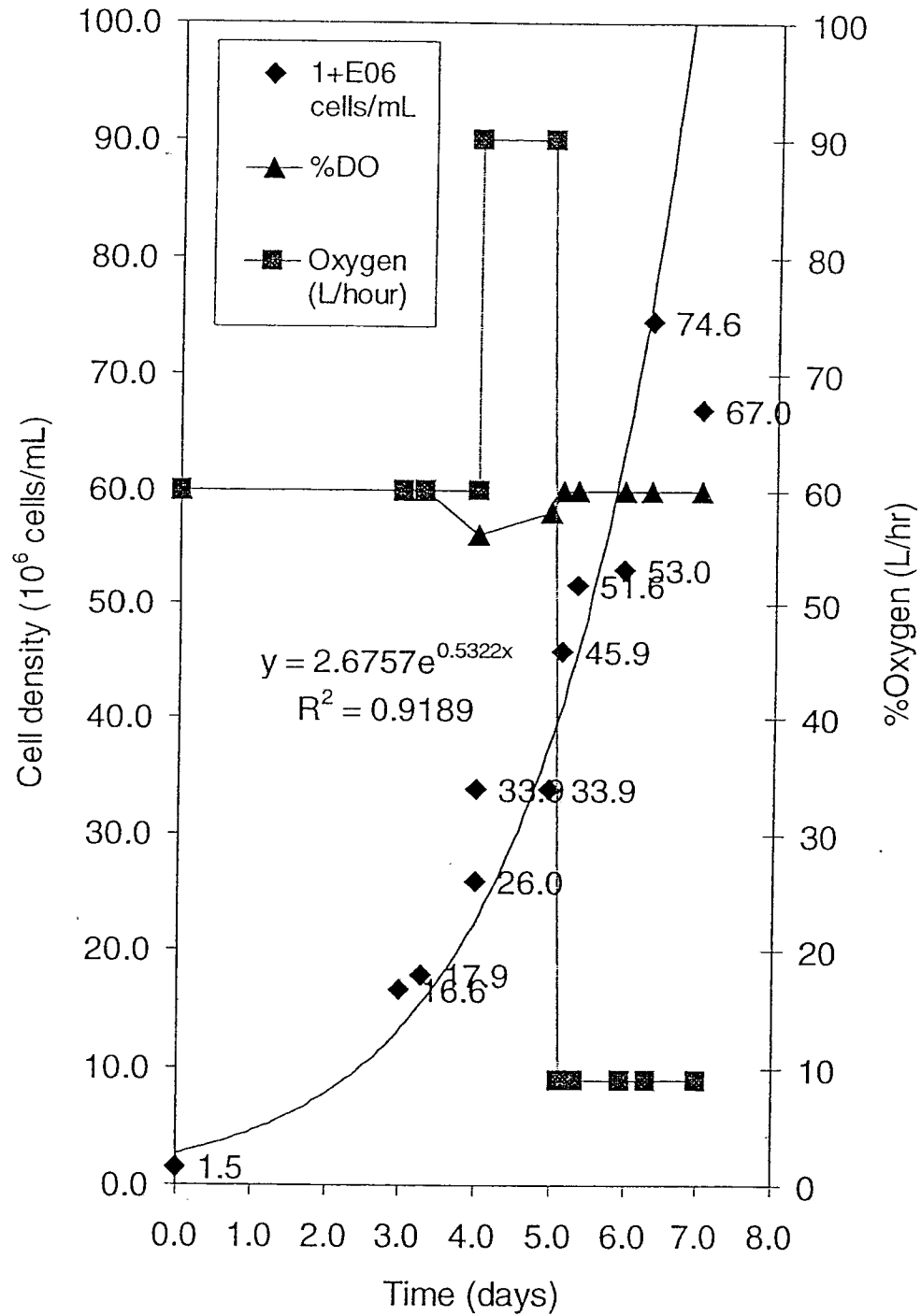


FIGURE 6 Yields of AcNPV Polyhedrin Protein in Standard and High-Density Cultures.

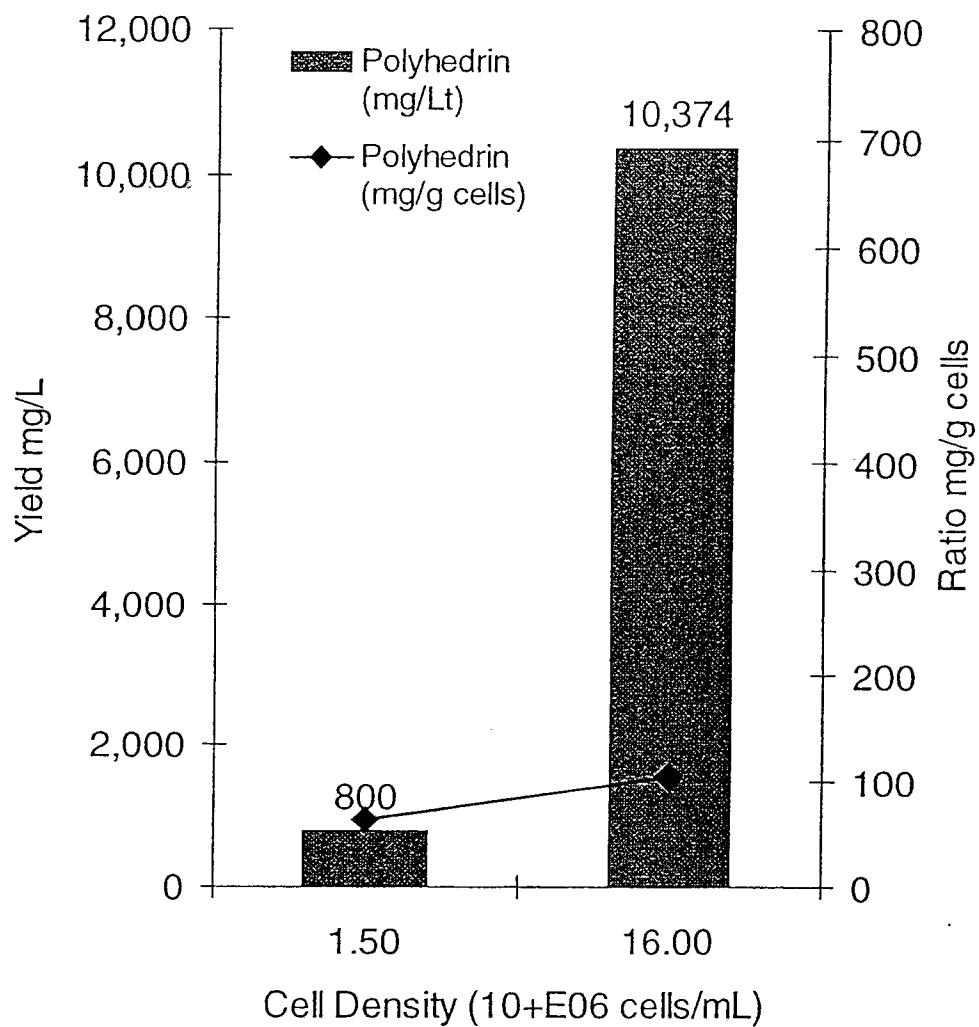
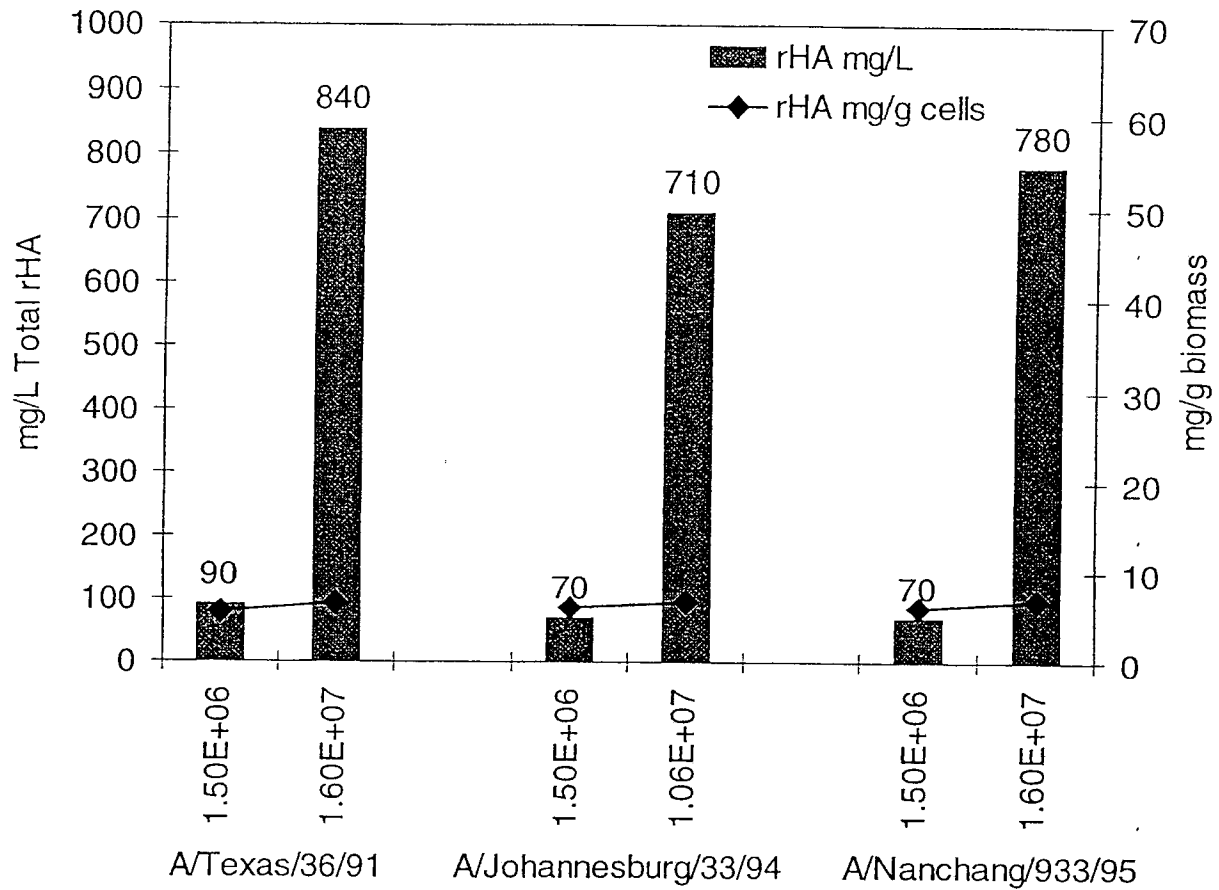


FIGURE 7 Yields of Recombinant Hemagglutinin from three Strains of Viral Influenza in Standard and High-Density Cultures.



Time	Time (days)	Cell density (1E6 cells/mL)	Culture Vol (L)	Oxygen (L/hour)	Dissolved oxygen (% biomass air saturation)	Cell biomass (g/L)	Auxiliary Reserv. (L)
8:4:00 PM	0.00	3.0	1	6	60		
11:4:00 PM	3.00	19.4	1	6	60		
11:6:20 PM	3.10	22.2	1	6	60		
12:8:30 AM	3.69	16.2	1	6	60		
12:10:30 AM	3.77	16.5	1	6	60		
12:2:30 PM	3.94	17.1	1	6	60		
13:9:20 AM	4.72	23.4	1	6	60		
13:3:30 PM	4.98	25.1	1	6	60		
14:8:30 AM	5.69	42.4	1	6	60		
14:1:10 PM	5.88	37.9	1	6	60		
14:5:00 PM	6.04	35.7	1	6	60		
15:9:00 AM	6.71	52.2	1	1.2	60		
15:2:10 PM	6.92	70.2	1	1.2	60		
16:10:30 AM	7.77	91.0	1	1.2	60		

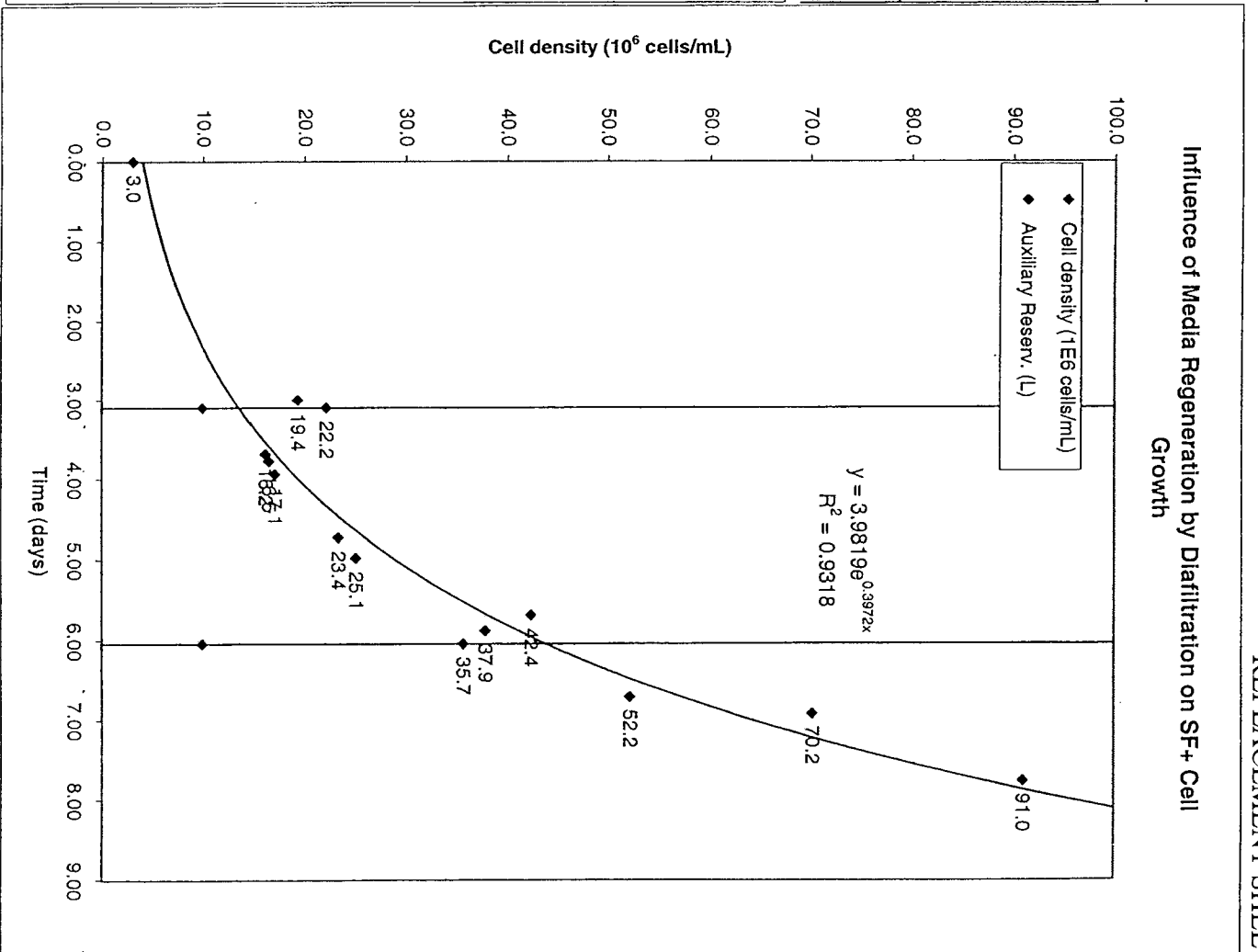
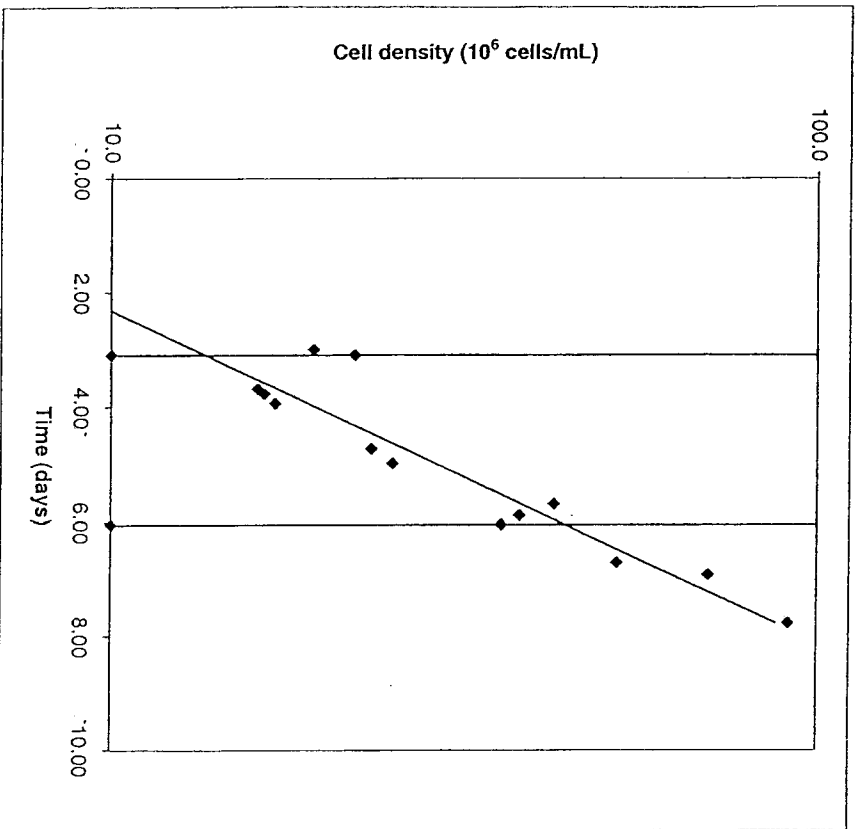


FIGURE 8

Figure 9**HD Bioreactor Diagram Legend****100 Cell Culturing Loop**

110	Stirred-tank Bioreactor
111	Bioreactor headplate
112	Cell take-up & cell take-up lines (112a – b)
113	Cell return & cell return lines (113a – b)
114	Probe ports: multiple (114a – 114e)
115	Sampling port
116	Vent tube
117	Sparging tube
120	Pump
130	Three-way valve & three-way valve line (130a)
140	Three-way valve & three-way valve line (140a)
150	Oxygenation Loop
151	Oxygenator & oxygenator Lumen (151a)
152	Lumen input
153	Lumen outflow
154	Gas input
155	Gas output
156	Solenoid

200 Medium Replenishment Loop

210	Media reservoir
211	Media container
212	Media take-up
213	Media return
214	Vent tube
215	Magnetic stir bar
216	Variable speed magnetic motor
220	Pump
230	“Extraction” loop and “extraction” loop lines (230a – c)
231	Three-way valve: pass-through or bypass in-line analysis
232	Three-way valve: collection or sampling
233	Three-way valve: pass through or return
240	Three-way valve – sampling & three-way valve – sampling line (240a)
250	Media take-up lines (250 & 250a)
260	Media return lines (260 & 260a – c)

300 Hollow Fiber Dialysis Device

301	Lumen input
302	Lumen outflow
303	Extra-lumenal input
304	Extra-lumenal outflow
310	Lumen space
320	Extra-lumen space

Days	Cell/ml $\times 10^6$	
	High density bioreactor (2L)	Control flask (0.1 L)
0	0.9	0.9
1	1.3	1.8
2	2.4	3.0
3	4.3	4.6
4	7.8	4.1
5	13.6	

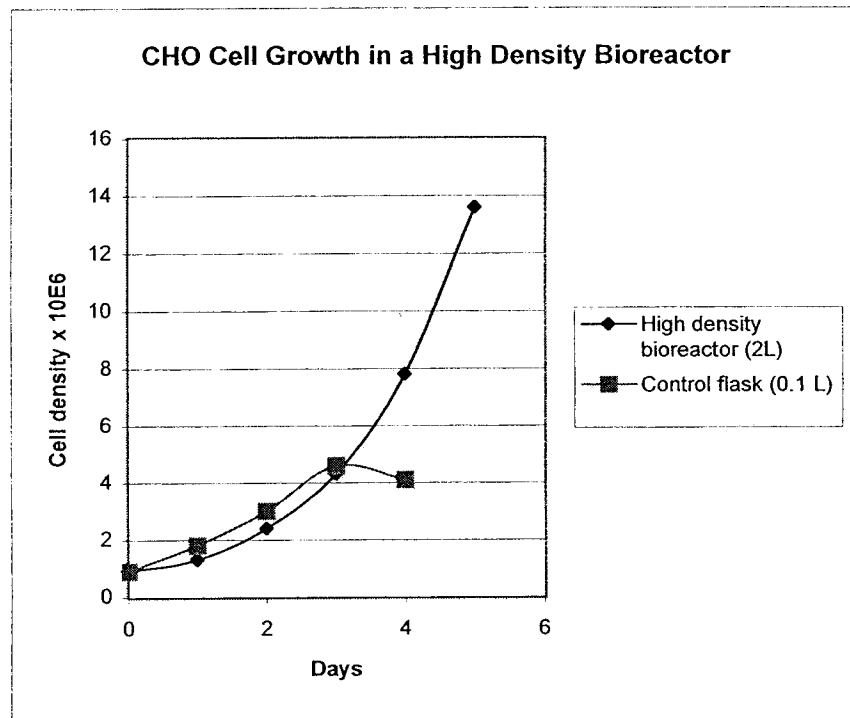


FIGURE 11